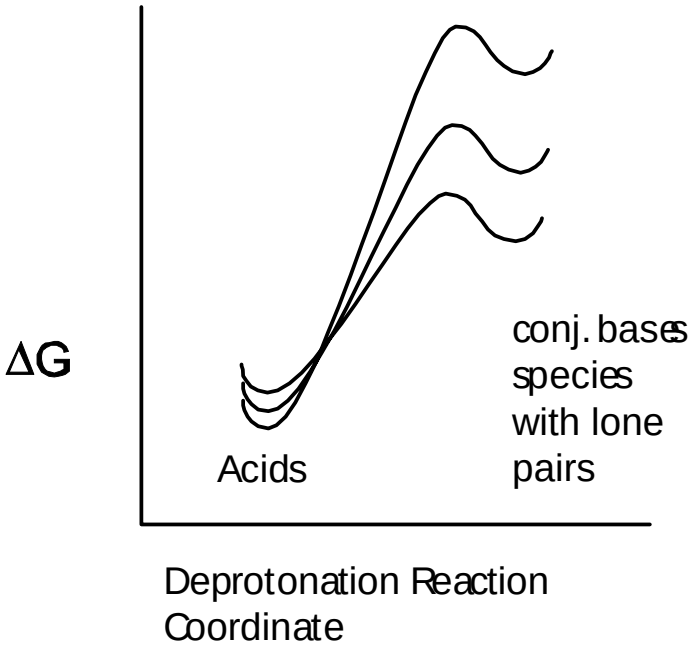
pKa is an Energy Term

- **A proton abstracted by a base is generalized in the following reaction**
  - $AH + B(-) \rightleftharpoons A(-) + BH$
  - We will worry about the descriptive details of how this happens later.
- **The half reaction in water is:**
  - $AH + H_2O \rightleftharpoons A(-) + H_3O(+)$
  - has an equilibrium constant associated with it
    - $K_{eq} = [A][H_3O]/[AH][H_2O]$
  - The terms in this equation are concentration. The molarity of water, $[H_2O]$ is 55 M or 55 moles/Liter
  - The acidity constant is
    - $K_a = K_{eq}[H_2O] = [A][H_3O]/[AH]$
    - Consider this equation: **$K_a = K_{eq}[H_2O]$**
- **Taking the negative log of both sides and multiplying by RT gives:**
  - $-RT\log K_a = -RT\log(K_{eq}[H_2O]) = -RT\log K_{eq} - RT\log[H_2O]$
    - R is the gas constant and T is the absolute temperature
    - $-2.30RT\log K_a = -RT\ln K_{eq} - RT\ln[H_2O]$
    - but $-\log K_a = pK_a$
    - and $-RT\ln K_{eq} = \Delta G$
    - **$2.30RTpK_a + RT\ln[H_2O] = \Delta G$**
    - Result: PKa increases linearly with energy!



The species with lone pairs (conjugate bases) respond more to structural changes than the acids.